

***Climate Change in the Built Environment:
Anticipating Grower, Landscape Design and
Maintenance, & Residential Client Challenges***

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Today's Discussion Topics

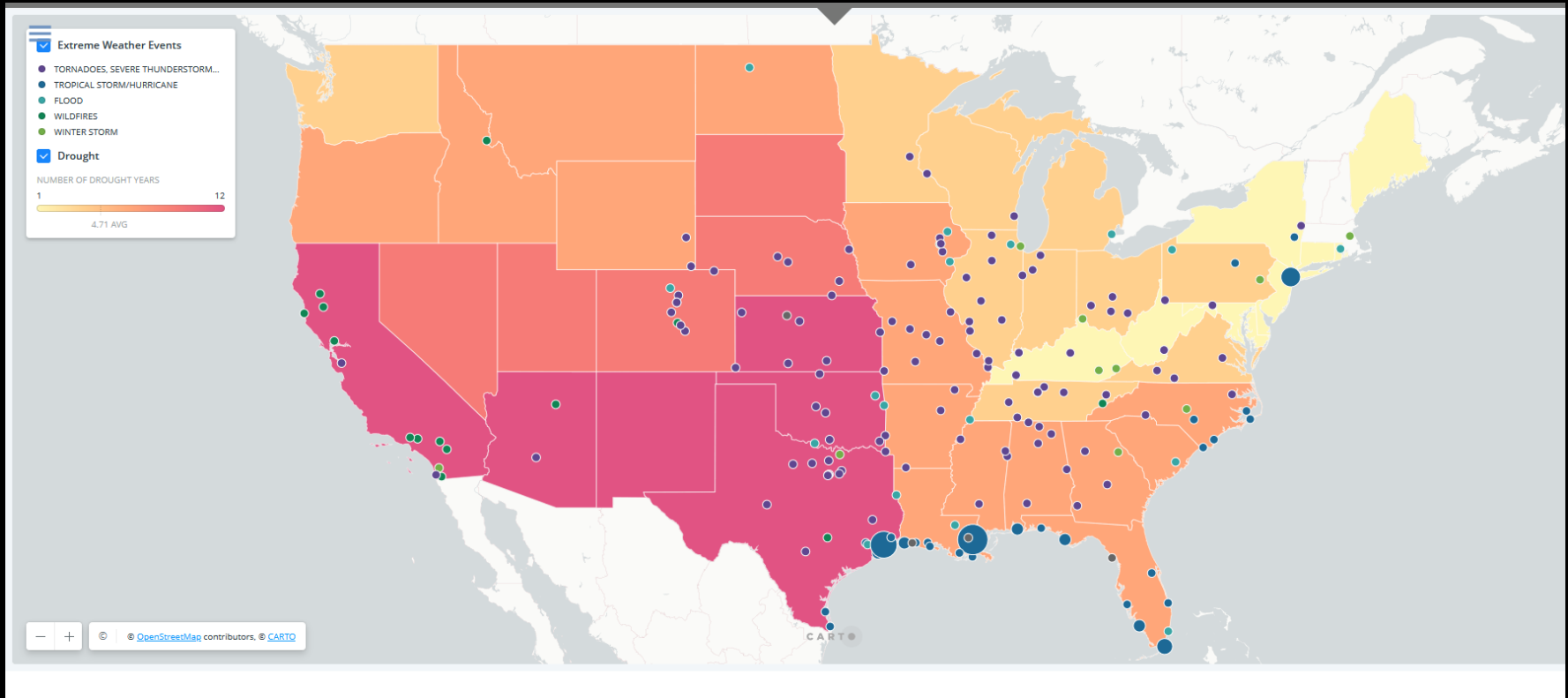
- **A case for climate change and why it will likely strongly impact built environments**
- **Readily predicable and less obvious issues**
- **Horticultural implications of climate change**
- **What can we do to adapt to the changes**

Climate Change ≠ Global Warming

- **Climate change is about deviations from typical weather and climatic events**
- **Could be long term changes in temperature, precipitation, etc.**
- **Could be more extreme variation despite only modest changes in mean levels**

Billion-Dollar Extreme Weather Events, 2000-2020

Events, 2000-2020



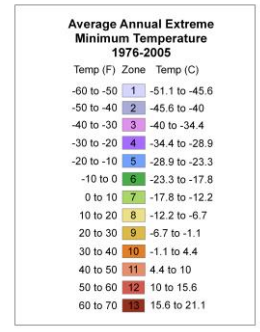
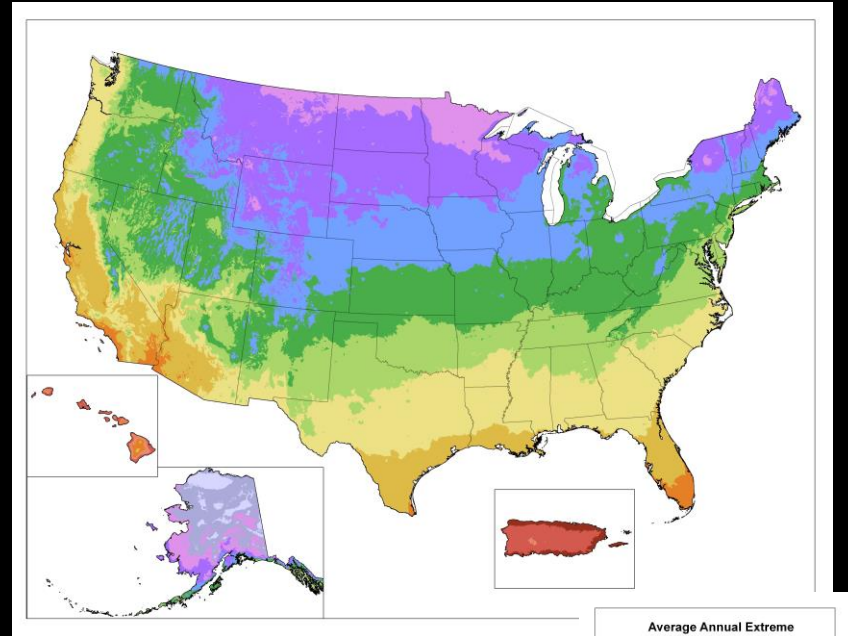
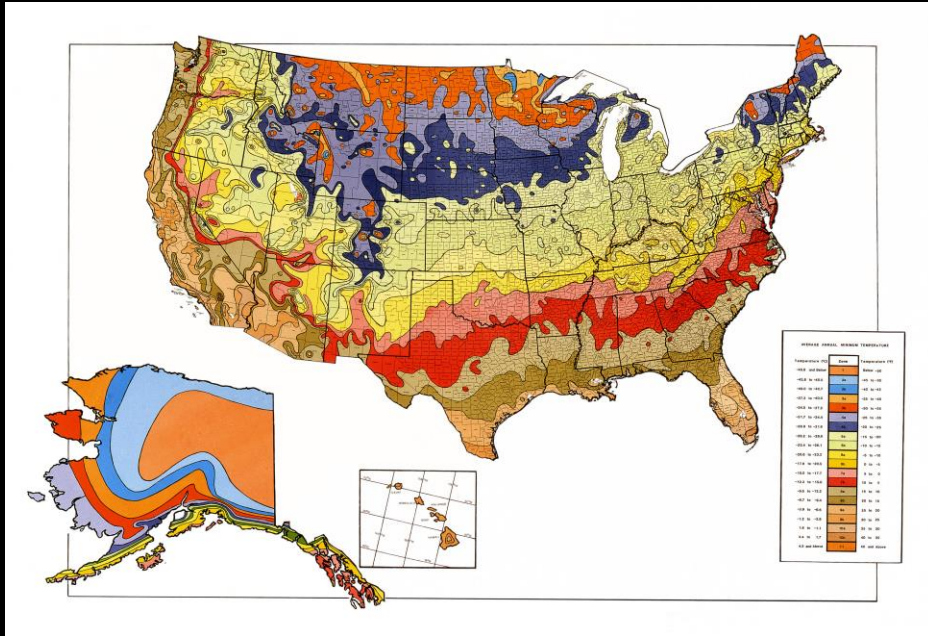
<https://www.c2es.org/content/extreme-weather-and-climate-change/>

Record Contiguous USA & World Warm Years

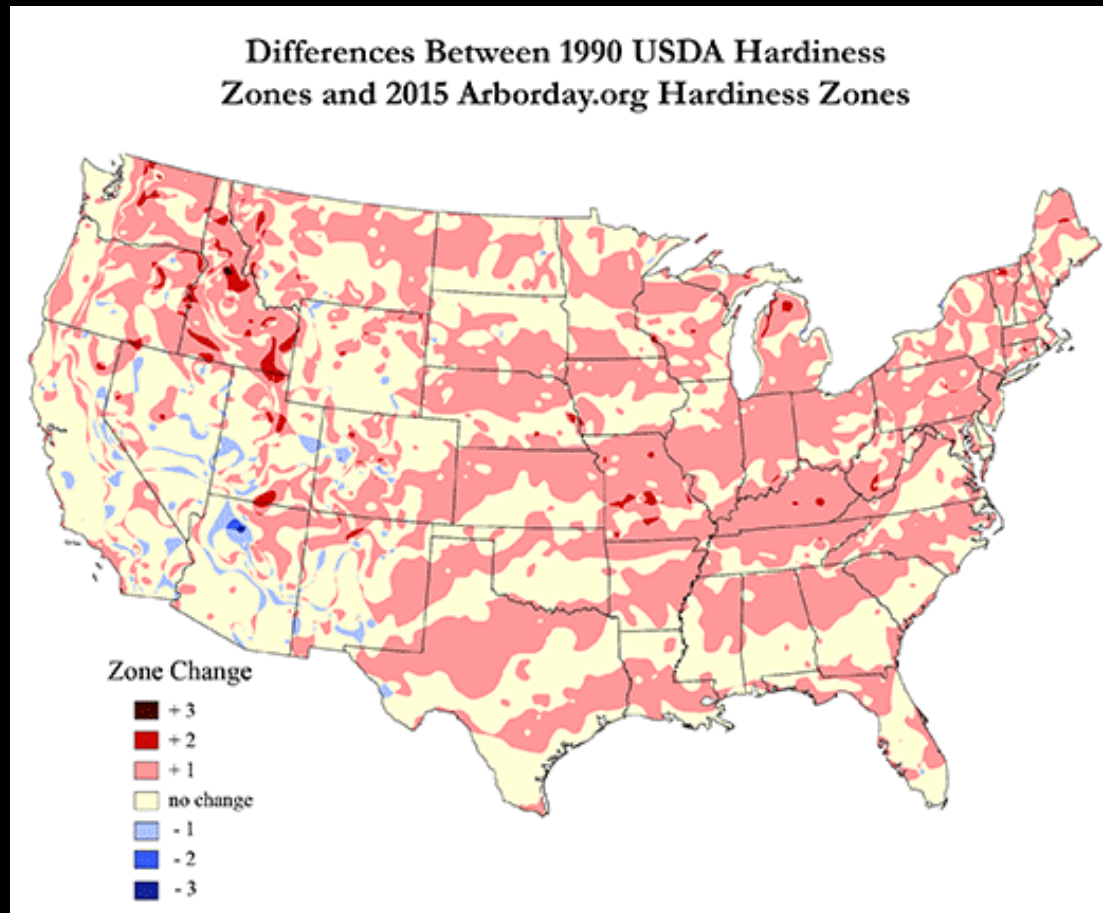
US EPA data indicates:

- Mean temperatures have risen in the contiguous 48 states since 1901**
- For contiguous 48 states 8 of the 10 warmest years on record have occurred since 1998**
- All 10 of the warmest years on record globally have occurred since 1998**
- Mean night temperatures have risen even more dramatically**

Compare 1990 to 2015 Maps

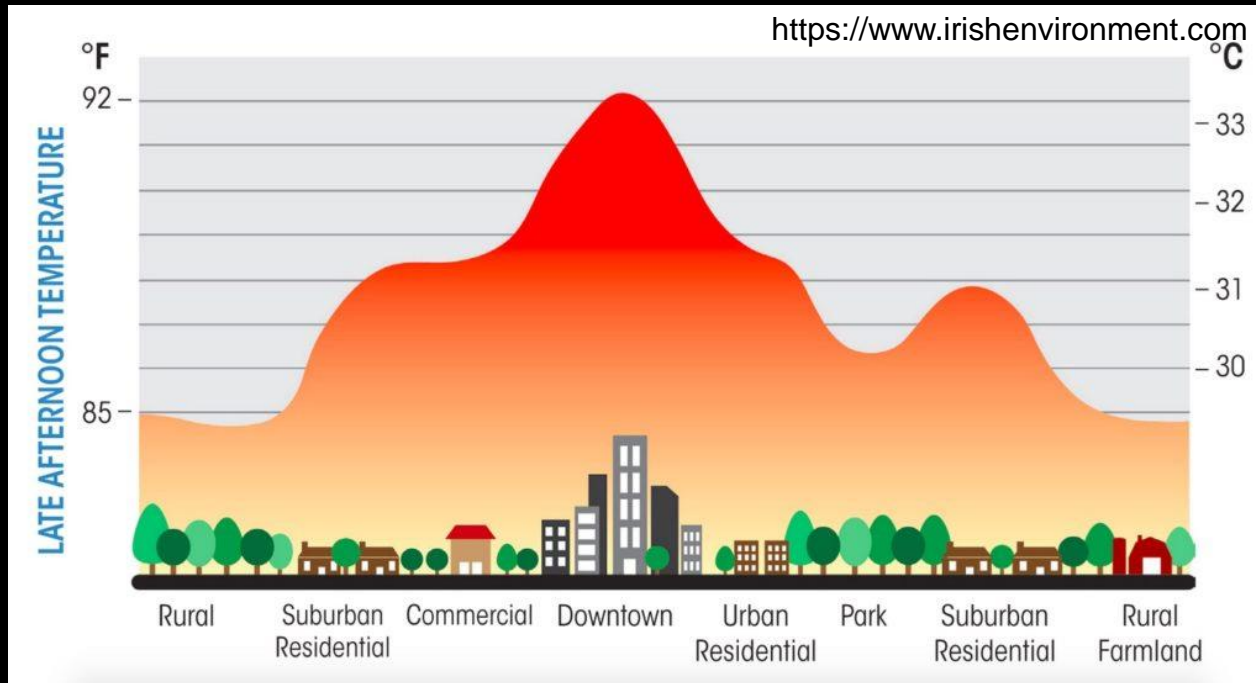


Changes in USDA Hardiness Maps 1990 - 2015



Most changed estimates have shifted to warmer zones

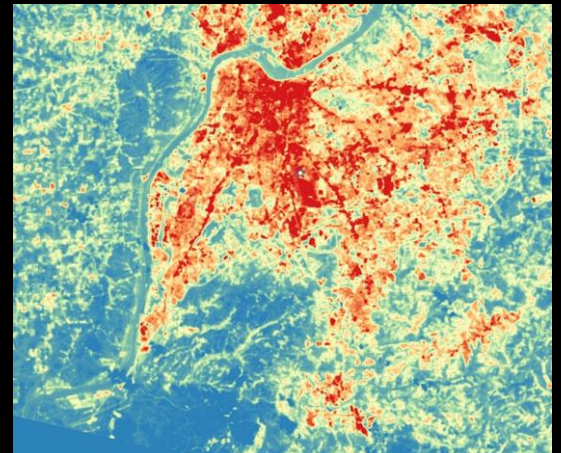
What Is An Urban Heat Island?



- **Impervious surfaces & buildings absorb heat**
- **Canyon-like streets inhibit air flow**
- **Refrigeration units & air conditioners generate heat**
- **Less vegetation means less evapotranspirational cooling**
- **In winter heat leaks from buildings**

Urban Heat Islands Exacerbate Climate Variability Impacts

- UHI can increase daily temperatures by as much as 27°F than surrounding rural area
- Across 60 largest U.S. cities, mean daily highs 2.4°F greater, 4.0°F higher at night
- 8 more 90°F days on average, many 20+ days, OKC was 22 days
- Increased ozone pollution
- From Climate Central.org



Louisville, KY UHI,
from Climate Central

Impacts of UHI on Plant Specification

- **In Madison, WI, UHI increased growing season length by ~5 days**
 - Zipper et al., 2016, *Environ. Res. Lett.*
- **May trick plants into leaf**
- **Potential favorable winter impacts of UHI**
 - Reduced winter heating
 - Expand palette of potential winter hardy plants



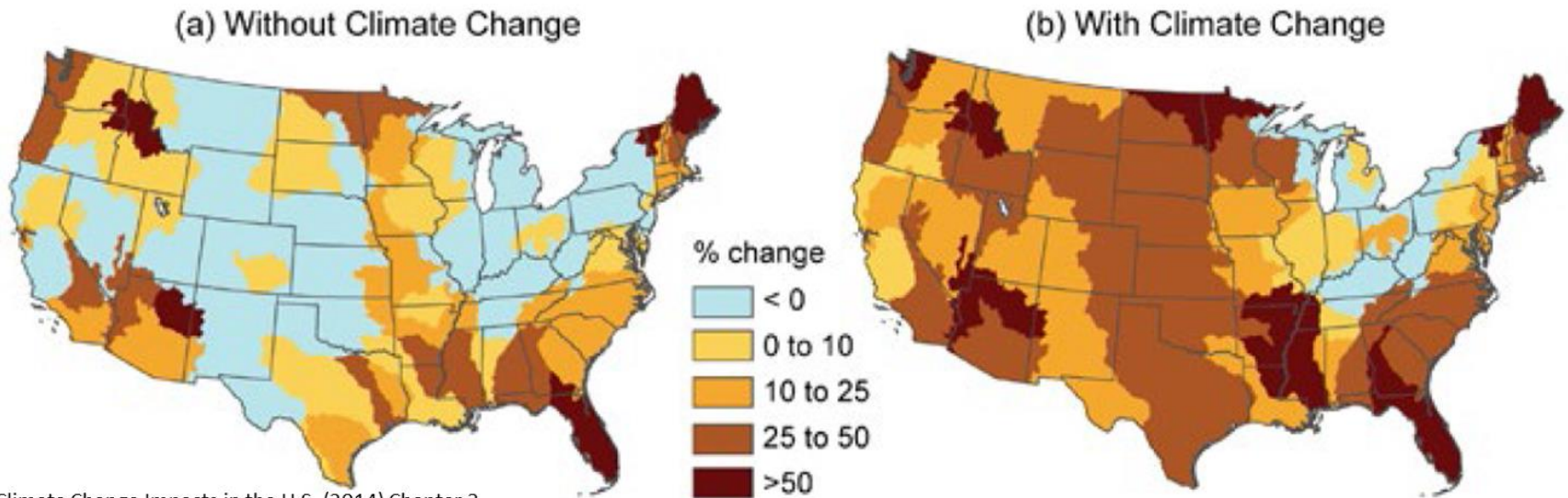
Projected new Maine coastal development?

Worldwide Trends Are For Additional Precipitation

- **Kicker is that it is regionally variable & SW USA is expected to become drier**
- **We have been experiencing an unusually wet climate in SW USA over the past 100 years.**

More, More, More!!!

Projected Changes in Water Withdrawals

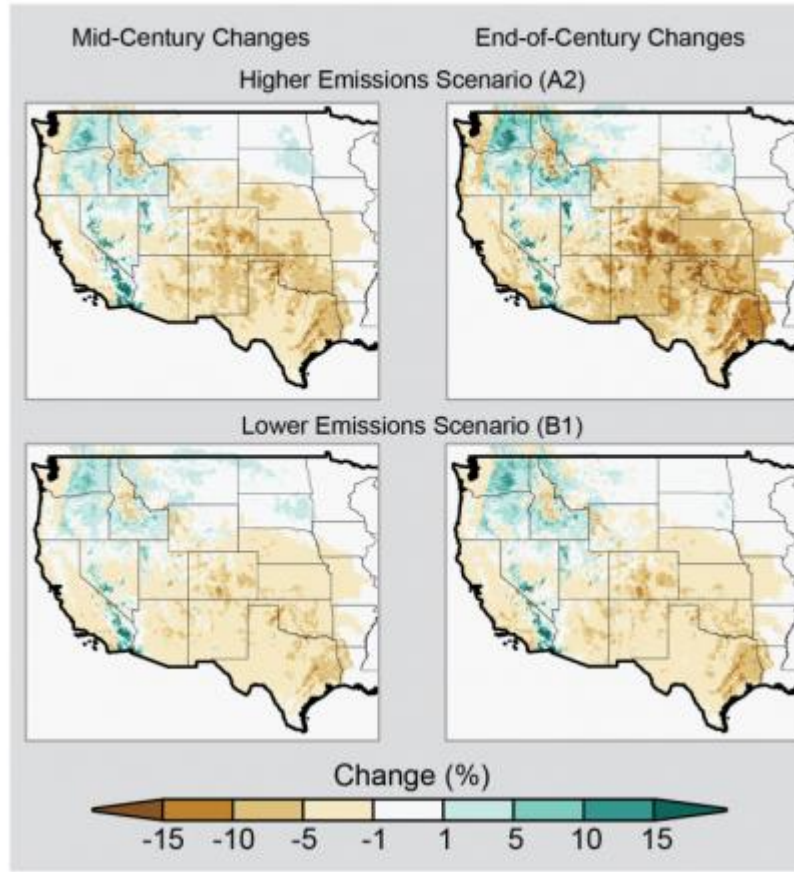


Climate Change Impacts in the U.S. (2014) Chapter 3

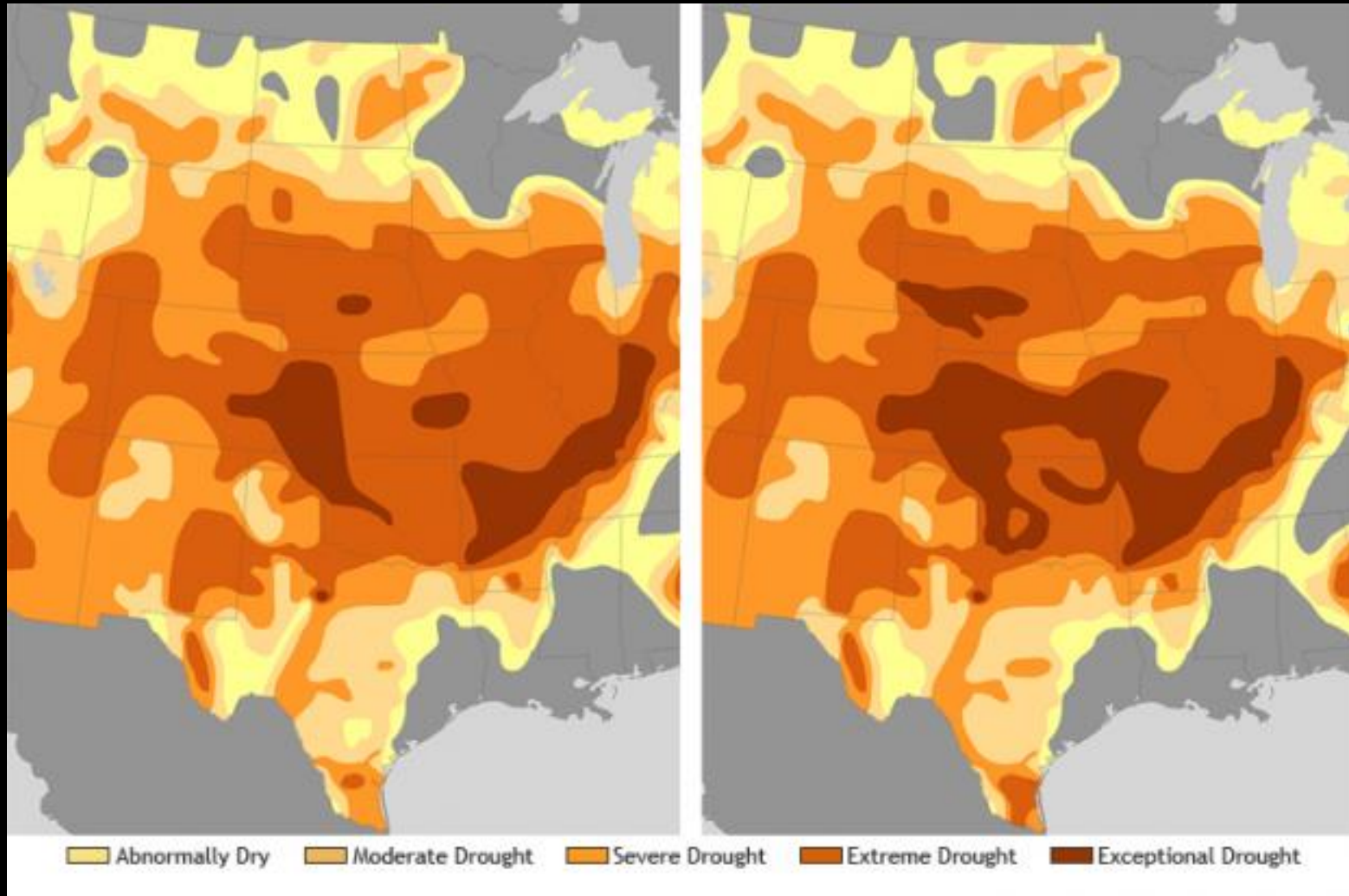
2005-2060

With Less & Less

Projected Changes in Soil Moisture for the Western U.S.

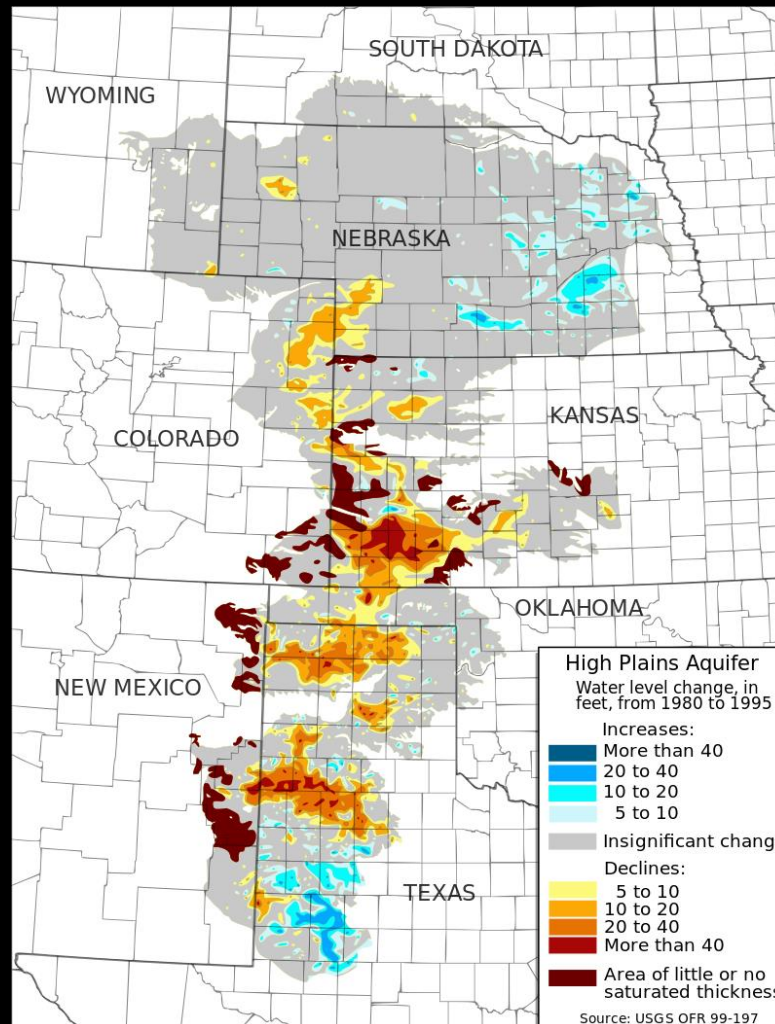


How Quickly We Forget?



From Kahn, 2012, Climate.gov

Ground Water Depletion & Reduced Recharge



Provenance Is An Issue!!!



Ilex decidua (regional orange-fruited)



Taxodium distichum
(western provenances)

Not All The Natives Made It



Ilex decidua 'Warren's Red'



Taxodium distichum
(eastern provenances)

DOA!

Rising Temperatures & Insect Predation Double Team Plants

- For every 1°C rise in mean surface temperature = 10 to 25% loss in grain yield
 - Deutsch et al., 2018, *Science* 361:916-919.
- Tomato study
 - Insect metabolism / growth increases with temperature
 - Predation increases Jasmonate / defensive compounds
 - Increased temperature diverts plant resources to cooling responses
 - Photosynthesis impaired, plant decline, yield decline
 - Houwat and Howe, Jan 20, 2020, *MSUToday*



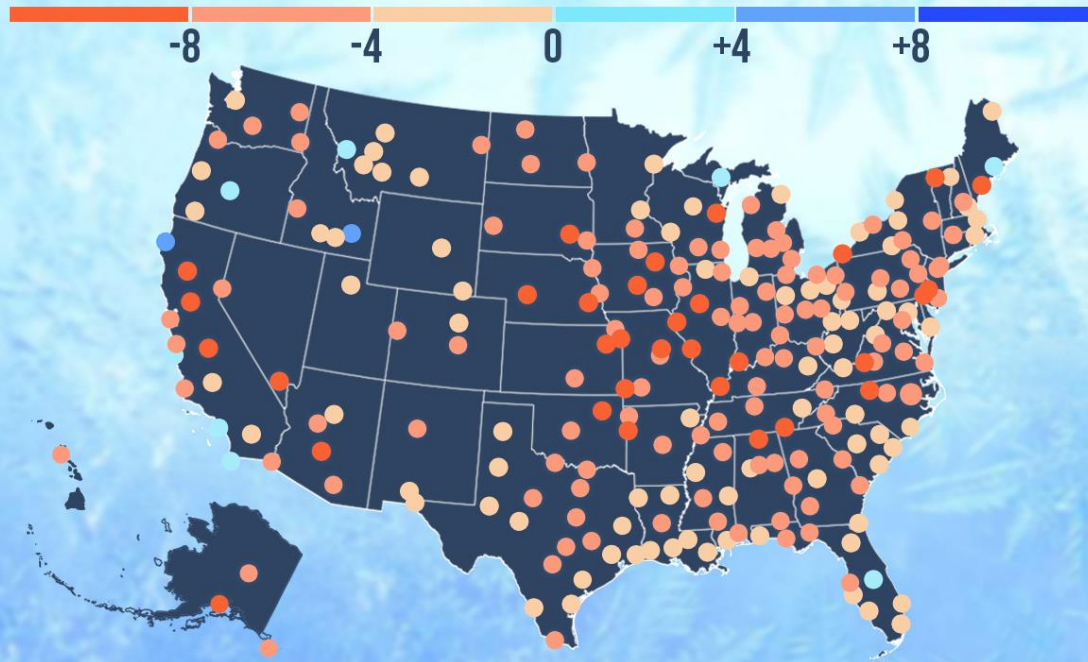
Warmer Winters & Drier Conditions Favor Borer Damage



Styphnolobium affine

Summer Heat Matters, But What About Winter Chilling?

WINTER LOSING ITS CHILL CHANGE IN LONGEST WINTER COLD SNAP (DAYS)



Change in average number of days in the longest annual streak of consecutive winter days below normal (1970-2019). Normal based on NCEI 1981-2010. Source: RCC-ACIS.org

CLIMATE  CENTRAL

Unanticipated Climate Change Consequences?



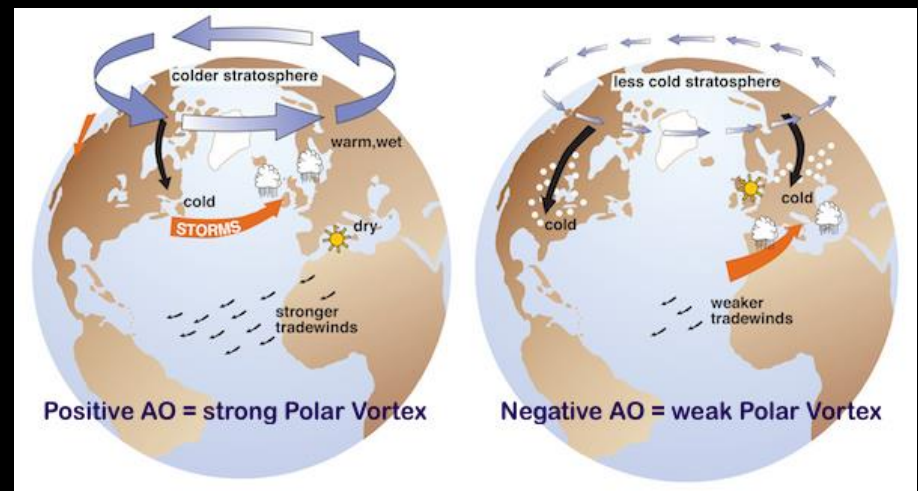
What's wrong with my Buttonbush?

Why Are My Buds Not Breaking?



So If Temperatures Are Rising, What Happened This Winter?

- Warmer air can hold more moisture, when cooled can produce more frozen precipitation – increased winter storm severity
- Greatest warming has occurred in arctic
- Weakened polar vortex weakens the jet stream which allows dips of arctic air into mid-latitudes
- May occur with greater frequency



In Much of Texas One of Coldest Winter Events On Record

- **Winter low in B/CS (6F) was equivalent to a typical winter low Lubbock**
- **Even native trees were injured / killed**
- **Why did some winter annuals survive and some subtropicals return from roots?**
 - **Snow cover was critical**
 - **We can modify by mulching**

Provenance Is Critical To Surviving Climatic Changes

- **Examples:**
 - *Quercus virginiana*
 - *Washingtonia robusta* vs. *W. filifera*



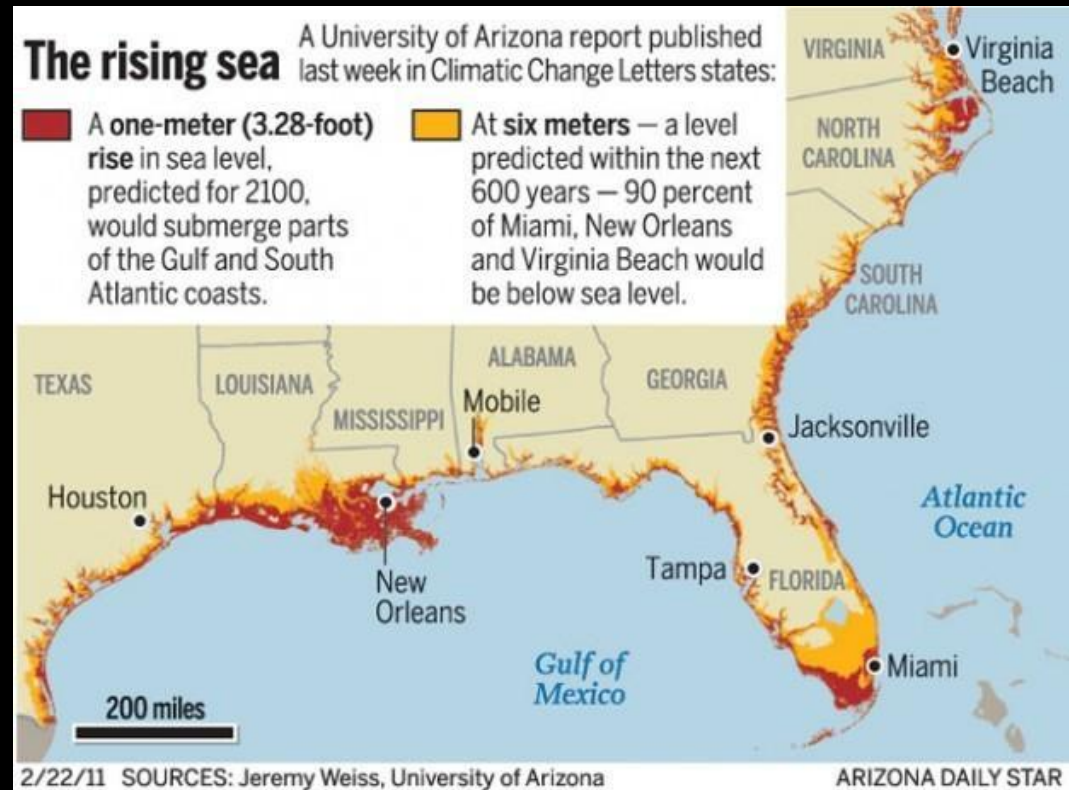
Washingtonia hybrids show differential cold tolerances



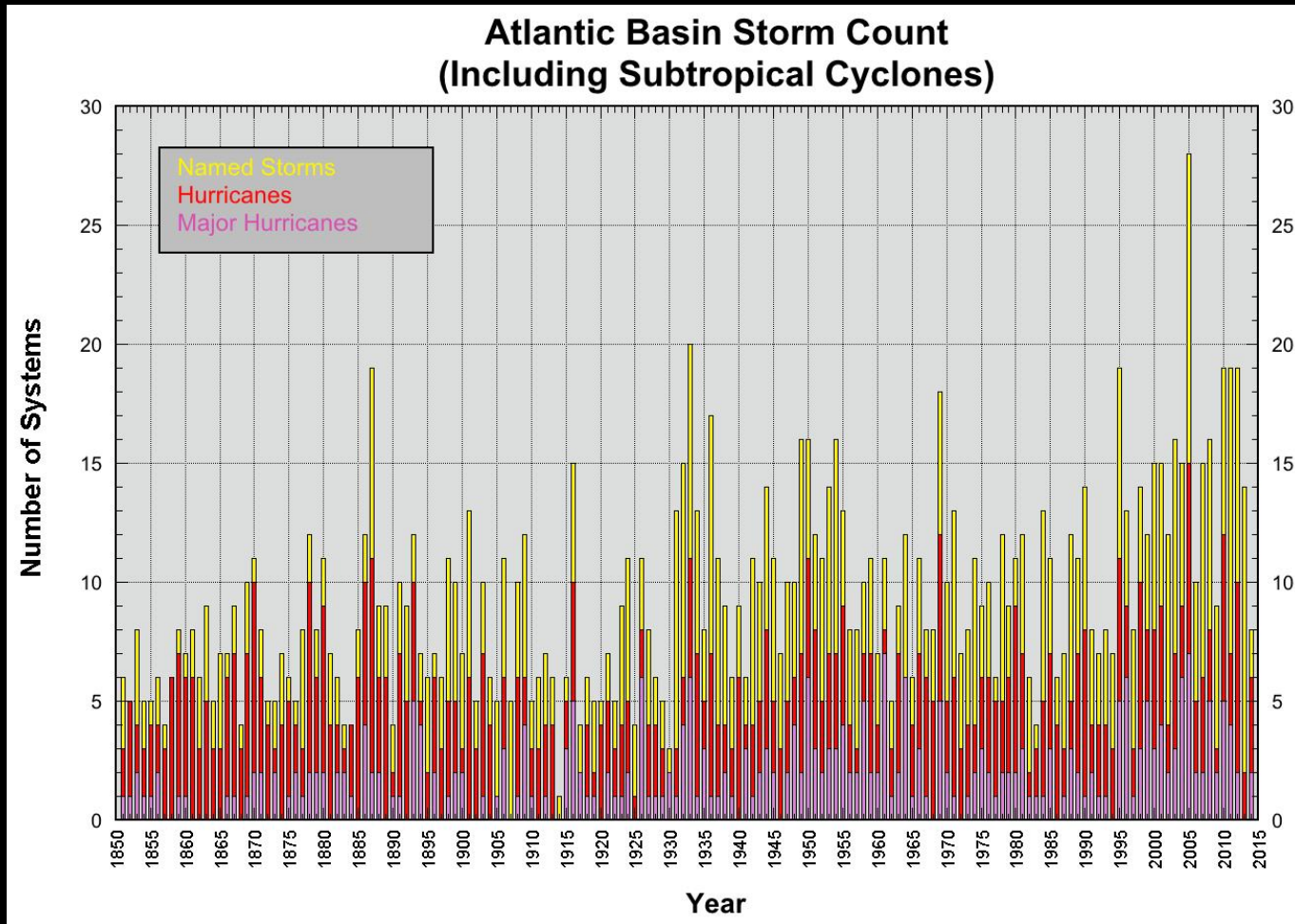
How Could We Forget Rising Ocean Levels?

- Inundation
- Increased severity of storm flooding
- Salt intrusion
- Saline tolerant plants will be at a premium

40% of US population resides in counties contiguous with a coast.



Increased Frequency & Intensity of Tropical Storms



National Hurricane Center

Increased Coastal Flooding / Wind



From nbcnews.com

Dune Preservation / Restoration

- **Critical coastal protection / preservation**



Increased Frequency & Intensity of Inland Storms

- **Increased emphasis on selection of trees with good scaffold branching**
- **Pruning to minimize canopy sail & reduce bark inclusion**



*So As Long As Climate Changes Our
Region To More Rainfall...
No Worries Right?*



Dynamics of Plant Geography

- **Typical rate of natural movement unlikely to keep pace with climate change – Cunze et al., 2013, Plos One**
 - Natural migration is tricky issue
- **Climate change may aid movement of invasives**
 - Weaken native ecosystems to invasion
 - Urban/peri-urban areas may serve as centers of origin of invasive plants
 - Alternatively may injure invasives as well

Is Black Mangrove Colonizing Coastal Areas Good or Bad?



Important Plant Selection / Specification Criteria

- **Heat tolerance**
- **Drought tolerance**
- **Flood tolerance**
- **Salinity tolerance**
- **Low chill requirements**
- **Pest / disease tolerance**
- **Strong branching structure**
- **Non-invasive characteristics or native**
- **Tolerance to rapid temperature change**
- **Provenance based breeding / selection**

Supertrees might be the answer!



**Gardens by the Bay –
harrytanphoto.wordpress.com**

What Measures Can We Take To Develop Resilient Built Environments?

- **Embrace diversity in landscape plants**
 - 5, 10, 15 (cons.) or 10, 15, 20 (optimistic)
- **Become cognizant of provenance**
 - Provenance not equal to seed source
- **Preserve coastal / riparian ecosystems**
- **Incorporate LID features in landscapes**
- **Recognize and exploit microclimates**
- **Accept the dynamic nature of gardens**

Come visit the most beautiful classroom in Texas!



<https://gardens.tamu.edu/>

“But if you close your eyes,
Does it almost feel like
Nothing changed at all?
Does it almost feel like
You’ve been here before?”

How am I gonna be an optimist about this?
How am I gonna be an optimist about this?...”

Pompeii - Bastille